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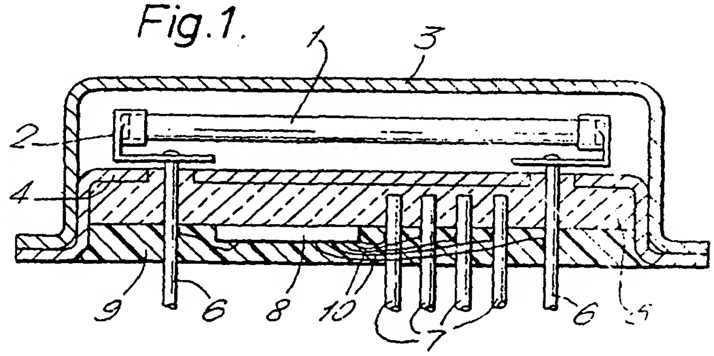
(54) **Piezo-electric resonator**

(57) A piezo-electric resonator unit includes a piezo-electric resonator element (1) mounted on a metal dividing wall (4) sealed in a metal casing (3). The element is connected through the wall (4) to circuit components (8) contained in a s aled cavity formed within a layer of potting compound (9). The wall (4) provides electromagnetic screening between the resonator element and the circuit components. The latter may include temperature-compensating and frequency-adjusting components.

Fig.1.



The drawing(s) originally filed were informal and th print here reproduced is taken from a later filed formal copy.

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Fig.1.

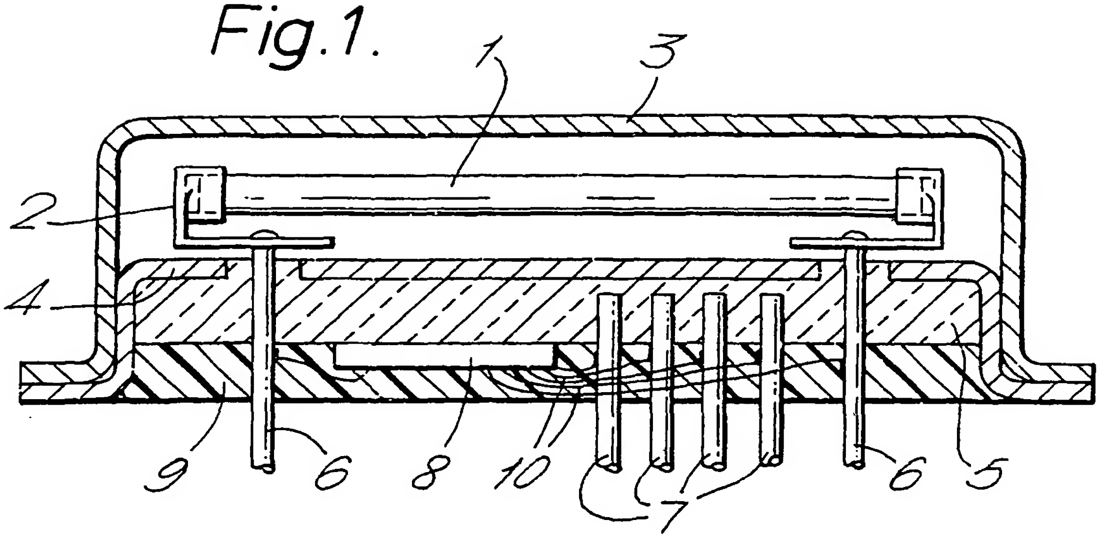


Fig.2.

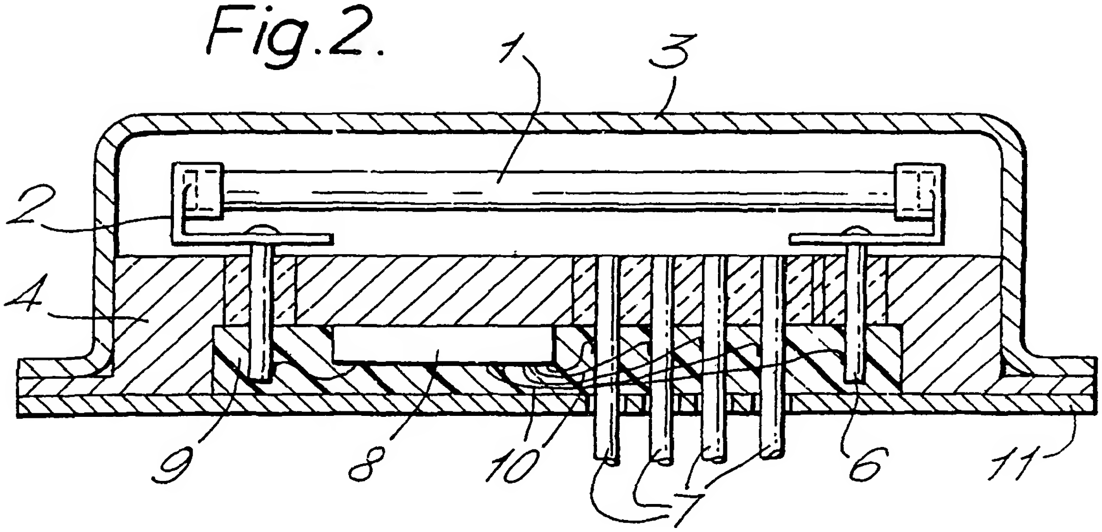


Fig.3.

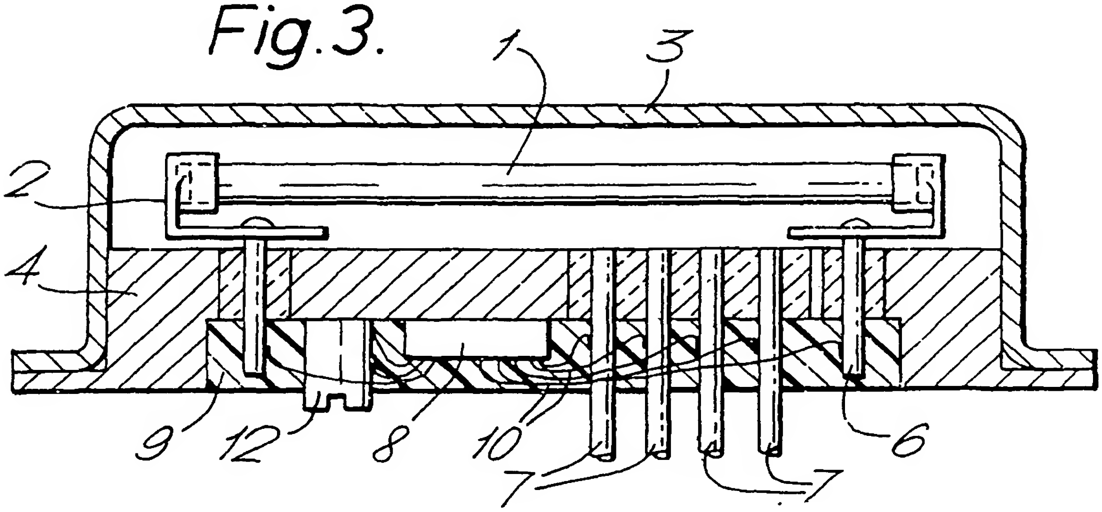


Fig. 4.

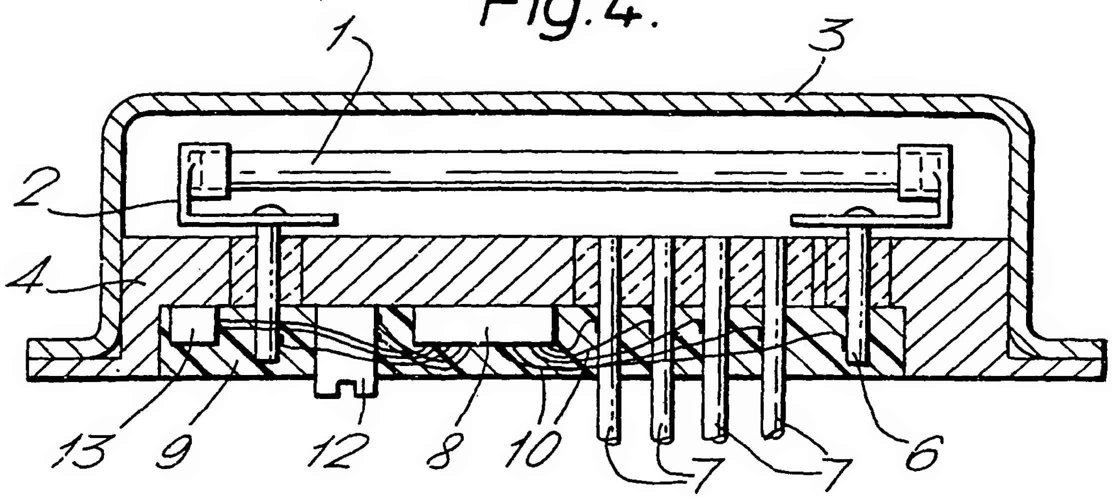


Fig. 5.

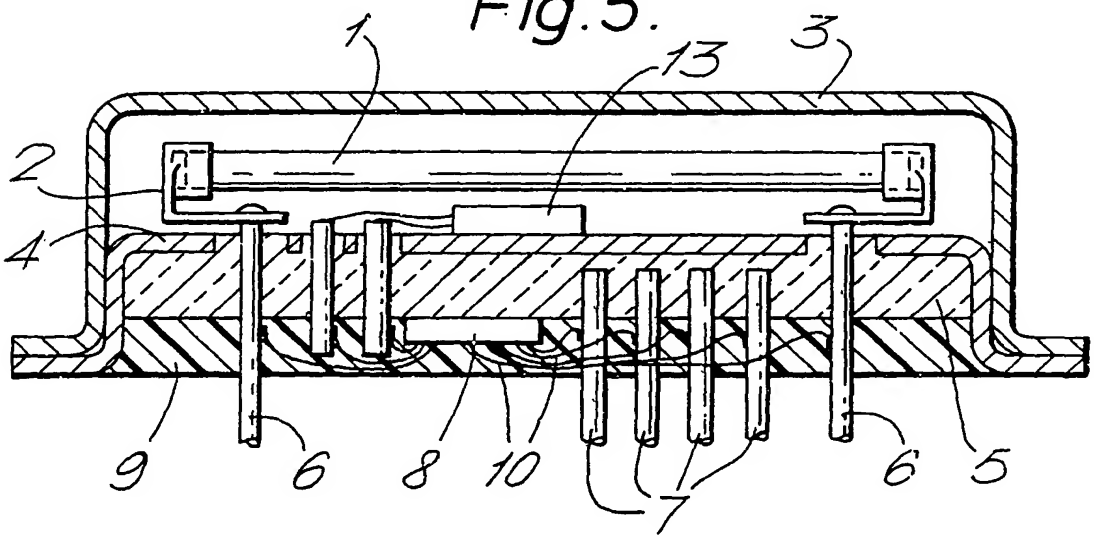


Fig. 6a.

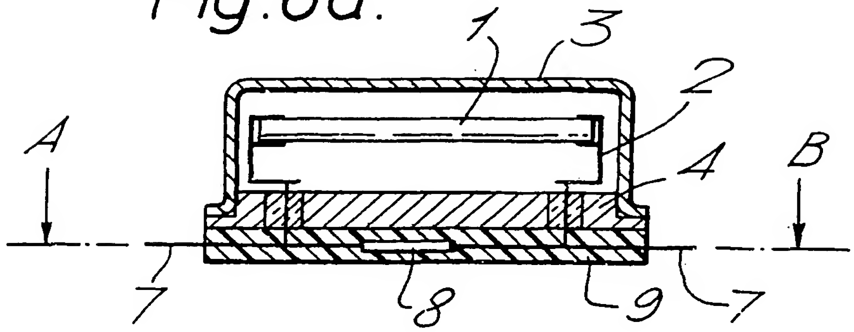
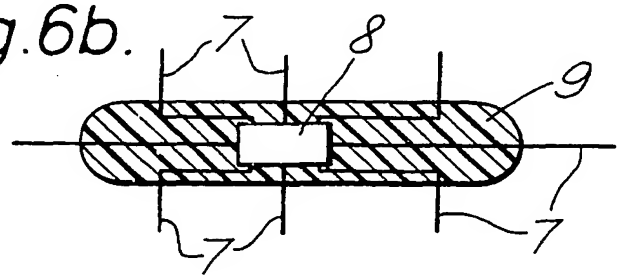


Fig. 6b.



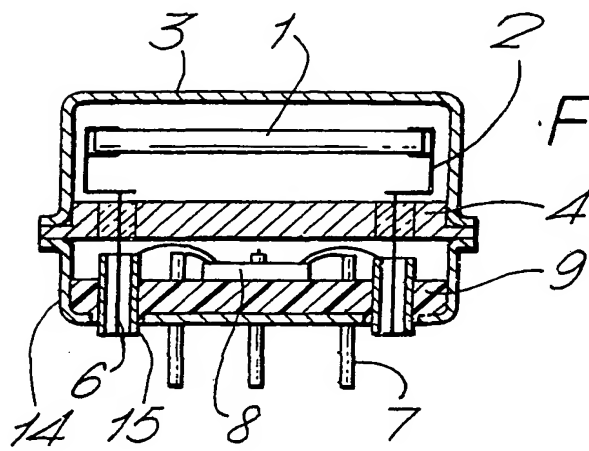
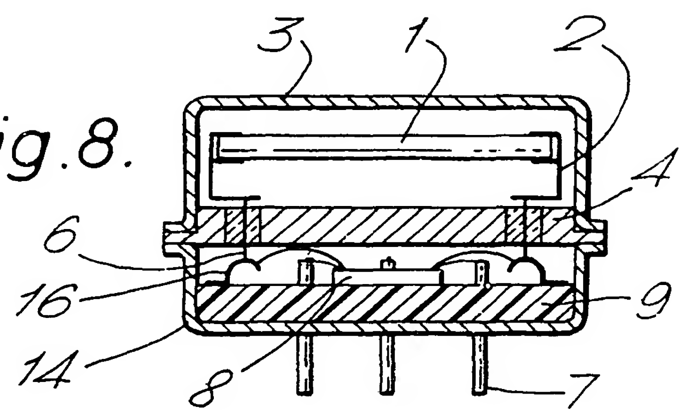


Fig. 7.

Fig. 8.



SPECIFICATION

Piezo-electric resonator

The present invention relates to a piezo-electric resonator unit and the components of the circuits influenced thereby.

Electrical resonators, such as crystal resonators, are very often used as the frequency-determining components of electrical circuits. In so doing, they form part of an oscillator circuit which may be followed by further circuits. Thus, for example, in electric-clock circuits, the oscillator circuit is followed by frequency-dividing circuits in order to step down the high frequency of the oscillator circuit to a lower frequency. These circuits sometimes contain discrete circuit components, but nowadays they are usually designed either partly of completely in the form of so-called integrated circuits, forming one single structural unit. For correcting the oscillator frequency, the resonator is mostly still preceded by a trimmer capacitor.

The resonator together with the oscillator circuit and also the frequency divider have been arranged on one common printed circuit board in order thus to obtain one single structural unit. The capacitances among the printed conductors required for this purpose, and between the printed conductors and the further circuit components arranged in proximity thereto, however, have a certain influence upon the frequency of the resonator, e.g. of the crystal resonator. Changing these capacitances, however, during the assembly of such a structural unit, or during later use, can have an adverse effect upon the accuracy of the entire oscillator arrangement. By combining the piezo-electric resonator and the circuit components of the subsequently arranged oscillator and divider circuit on one single mounting board, the danger of varying the circuit capacitances, of course, is reduced, but such an arrangement bears the disadvantage that the resonator and the other circuit components are accommodated in one single space common to both, thus causing unwanted interactions.

According to the invention there is provided a piezo-electric resonator unit comprising a piezo-electric resonator element mounted on one side of a metal dividing wall with insulated electrical connections passing therethrough from the element, the element being contained within a metal casing which is sealed by the dividing wall, the unit including discrete circuit components mounted within a sealed cavity on the other side of the dividing wall, said components being electrically connected with the element.

In this way there is obtained, on one hand, the advantage of short lines and unvariable line or circuit capacitances and, on the other hand, the resonator is prevented from being influenced by the other components of the circuit.

Embodiments of the invention will now be explained in greater detail with reference to Figures 1 to 8 of the accompanying drawings showing sectional views taken through structural units according to the invention.

Figure 6b is a section taken through the arrangement shown in Figure 6a.

In the structural unit shown sectionally in Figure 1, the reference numeral 1 indicates the resonator element, e.g. a crystal resonator, which is mounted in a holder 2 in a casing 3 and is connected to the terminals 6. The casing 3 is tightly sealed by the bottom part 4 (dividing wall) and the terminals 6 for the resonator 1 are led through the bottom part 4 in an insulated fashion. The insulation is effected, for example, with the aid of a glass layer 5. The bottom part 4 is so designed as to be arched towards the inside of the casing, thus forming a cavity towards the outside. In this cavity the components 8 of the oscillator circuit, which may e.g. have the shape of an integrated circuit, are arranged and sealed with respect to surroundings, with the aid of the insulating compound 9. The terminals 7 for the circuit components 8 are embedded in the glass compound 5, and retained therein. In many cases, however, it will be sufficient to fix the terminals 7 in the insulating compound 9. With the aid of the connecting lines 10, the circuit components 8 are connected to the terminals 7 and, via the terminals 6, to the resonator 1.

In the arrangement according to Figure 2, the casing 3 is likewise sealed by the bottom part 4 which, in this particular case, consists of a solid part with a cavity worked into the outside thereof. The resonator 1 is again fixed in the holder 2, and the terminals 6 are led tightly through the bottom part 4. In this case, however, they do not extend to the outside, but end in the insulating compound 9 in which also the components of the oscillator circuit are embedded. The terminals for the circuit components 8 are again fixed in an insulated manner in the bottom part 4 and project towards the outside on the bottom side of the structural unit. With the aid of the connecting lines 10, the circuit components 8 are connected to the resonator and to the terminals 7. For the purpose of shielding the circuit components 8 with respect to electric fields, a metal layer 11 is arranged over the entire bottom part, especially on the insulating compound 9. This metal layer may be produced by metalising the insulating compound on its outside, in the manner known per se. Instead of a metalising layer 11, it is equally well possible to arrange a metal plate on the bottom side of the unit. Of course, the layer 11 is provided with recesses around the terminals 7, so as to insulate the terminals 7 from the metal layer 11.

The arrangement according to Figure 3 corresponds substantially to that of Figure 2, with the difference that a tunable circuit component 12, such as a trimmer capacitor, is arranged in such a way in the insulating compound that after completion of the structural unit, the component 12 may be readjusted from the outside. This makes it possible to carry out a retuning in the event of any frequency errors (deviations). The trimmer capacitor 12 is connected to the crystal oscillator 1 in the manner known per se.

The arrangement according to Figure 4 corresponds substantially to the arrangement shown in Figure 2, with the difference that, for the purpose of effecting a temperature compensation, a component 13 having temperature dependent properties, such as a resistor having a negative temperature coefficient of the resistance value, is arranged within the bottom part 4. This component serves to compensate for the temperature-dependence of the components of the oscillator circuit 8. For readjusting the frequency, the trimmer capacitor 12 which is accessible from the outside, is also provided for in this case.

Considering that with the structural unit according to the invention, the resonator, on one hand, and the circuit elements, on the other hand, are positioned in separate spaces, also the temperature on either side of the dividing wall, which is preferably formed by the bottom part 4, will be different as a rule. For achieving a temperature compensation of the crystal resonator 1, therefore, it may be of further advantage to arrange an electric circuit component having temperature-dependent properties inside the casing itself in the direct proximity of the resonator 1. Such an arrangement is shown in Figure 5. The component 13 having temperature-dependent properties is shown arranged in the direct proximity of the resonator 1. Of course, also in this arrangement it is still possible to provide an additional component having temperature-dependent properties in the proximity of the circuit components 8.

A further type of embodiment of the invention is shown in Figures 6a and 6b, with Figure 6b showing a section taken on line A—B of Figure 6a. In this case, the bottom part 4 of the casing 3 carrying the resonator 1 is designed to have the shape of a flat plate, and the circuit components 8 are arranged below the plate in a layer of insulating compound 9 arranged thereon. As can be seen especially from Figure 6b, the terminals 7 of the circuit components 8 are led, in this case, towards the side, i.e. out of the layer 9 of the insulating compound (potting resin).

In the examples of embodiment according to Figures 7 and 8 the circuit components are arranged on the outside of the bottom part 4 designed to have the shape of a plate (board), and tightly sealed with respect to surroundings by a cap (cover) 14 placed thereon.

In the type of embodiment shown in Figure 7, small metal tubes 15 are embedded in the cap and in the insulating compound 9 cast therein, into which the terminals 6 of the resonator 1 project. With the aid of small tubes 15 it is possible, for example, for the space between the bottom part 4 and the cap 14 to be either evacuated or filled with a protective gas. Finally, the small tubes 15 are sealed on their outsides by way of soldering or welding. This simultaneously results in an electrically conducting connection with the terminals 6 of the resonator 1. The small tubes 15, however, may also be connected electrically to the circuit components 8 inside (within) the cap 14.

Figure 8 corresponds substantially to the type of embodiment shown in Figure 7, with the circuit components 8 being positioned between the cap 14 and the bottom part 4. The electrical connection between the terminals 6 of the resonator 1 and the circuit components 8 is established in this case with the aid of two contact springs 16 on which the terminals 6 rest after having been assembled. The terminals 7 of the circuit components are led to the outside in an insulated manner through the cap 14.

The casing 3 in each case is preferably made of metal and the dividing wall 4 is also metal to provide electro-magnetic screening. In Figures 7 and 8 the cap 14 is also preferably made of metal.

In all of the described types of embodiment, the circuit components of the oscillator circuit and, if so required, the divider circuit on one hand, and the resonators on the other hand, are accommodated in separate spaces screened from one another, thus preventing them from influencing one another, but combined to form one compact structural unit.

CLAIMS

1. A piezo-electric resonator unit comprising a piezo-electric resonator element mounted on one side of a metal dividing wall with insulated electrical connections passing therethrough from the element, the element being contained within a metal casing which is sealed by the dividing wall, the unit including discrete circuit components mounted within a sealed cavity on the other side of the dividing wall, said components being electrically connected with the element.

2. A unit according to claim 1 wherein the discrete components are embedded in a layer of potting compound.

3. A unit according to claim 1 or 2 wherein the dividing wall is shaped to provide a cavity within which the discrete components are embedded in a layer of potting compound.

4. A unit according to claim 1, 2 or 3 wherein the sealed cavity containing the discrete components is formed between the metal dividing wall and a metal cap or the like which is sealed to the dividing wall.

5. A unit according to any preceding claim wherein the discrete components include an adjustable trimming capacitor accessible externally of the unit for adjustment purposes.

6. A unit according to any preceding claim wherein the discrete components include a component having predetermined temperature dependent properties.

7. A unit according to any preceding claim including in that part of the casing containing the element a component having predetermined temperature dependent properties.

8. A piezo-electric resonator unit substantially

as described with reference to Figure 1 or Figure 2 or Figure 3 or Figure 4 or Figure 5 or Figures 6a and 6b or Figure 7 or Figure 8 of the accompanying drawings.

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